Manual of Cardboard Construction

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BY

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BERKELEY SCHOOLS

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This pamphlet has been prepared by Mr. Leonard, our Supervisor of Manual Training, for the assistance of the teachers of the grades for which the work is outlined, and it has received the sanction of the Board of Education, and thus becomes a part of our school course.

Its purpose is to make the method of procedure clear and definite for those who are to carry on the work in these grades, and it will undoubtedly contribute much to securing the success in this branch of our work, for which we are all so earnestly striving.

S. D. Waterman,
City Superintendent.

Berkeley, December 20, 1907.

Introduction

This manual is presented with the object of showing the purpose and scope of cardboard construction, and developing methods of presentation for classes of the third and fourth grades. For this purpose, some subordinate topics must be treated, such as: Current Opinions and Practice, Accuracy, Design, Use and Selection of Materials, Definite Processes, etc. No complete set of models is herein presented, for reasons given later.

From what is generally presented upon the subject, one might expect to find a definite, clear-cut course, minute and explicit in every detail. One might even think that such would be the most help to the teacher. A moment's consideration must reveal the fact that such is not the case; as models, exercises, or definite projects can be presented properly only when one comprehends the purpose of their presentation and realizes their full significance. In other words, and to make a more general statement, no subject can be properly taught till we grasp its spirit and are able to see its full content and bearing. Once the keynote has been found, details and necessary externals will adjust themselves; all forming one harmonious unit.

ROBERT J. LEONARD.

Current Opinions and Practice

Teachers and specialists advance many reasons for teaching cardboard construction. Summing them up briefly, they are: That such teaching develops accuracy, neatness, precision, sense of form, proportion and beauty. A careful analysis shows these to be adult accomplishments, for the most part, to be acquired only by patient effort and long association with mechanical and artistic productions. The ordinary method of presentation tends to emphasize these points. We would not underestimate the value of these accomplishments, but over and above them, we must place the thought of mental development and unfolding. Certainly the above mentioned attainments are marks and evidences of mental development, but only that quality of mentality which enables the child to execute what another has planned; all of which does not show that he is gaining the power which is going to enable him to plan for himself, to deal with problems individually; or, in other words, to develop him so that he will be fitted to combat with the problems of life which cannot be solved by rule, but which demand individuality and a power to think and plan for himself.

Construction work may be used as a means toward this end if it is presented with this thought in mind. As a general thing, it drifts into a course in mechanical drawing, presented by either dictating or copying the plan of the object. Supporters of these methods advance the following arguments in their favor. The child learns to follow directions minutely as they are laid down, thus enabling him to execute with precision and accuracy the problems presented. He acquires a conception of various geometric forms, thereby forming a

basis for mensuration and the general application of arithmetical principles. He is enabled to read a mechanical drawing quickly, forming a basis for the wood-work of the upper grades.

These facts are mentioned to show that by means other than dictation and mechanical drawing, all these points may be brought out, and not at the expense of the child's initiative and individuality.

Truly, our work must be carefully planned. but we must not be satisfied with developing only the powers of accuracy and neatness. Mechanical skill is a secondary consideration. Unless we proceed with this thought in view, our work will become stereotyped in form, and instead of developing the innate powers of the child, will tend to place him on the mental level of the shop hand who receives his orders every morning and gradually loses his powers of choice and becomes a human machine.

What to Present

Upon examining various courses of study, we find a great variety of projects for third and fourth-grade work. Some are based entirely upon geometric forms; others upon articles of use and adornment about the house; others upon toys which enter into the play life of the child; still others upon nothing possessing human interest whatever. Let us, if possible, lay down a broad truth, so that we may have a standard upon which it will be safe to rely.

Cardboard construction is generally presented in such a way that the children are forced to work from the plan to the object; that is, the teacher devises the plan and presents it to the class, insisting that the pupils' ideas conform to those presented. Most of the thinking is done in the formation of the plan, so that the teacher is really the one most benefited. By reason of this method, we often come across a plan that is

not intelligible to a trained eye, much less to the child's. Light begins to dawn only after cutting and folding. This would not be the case if we worked from the object to the plan. Therefore, the only projects which we should present are those which the child is capable of visualizing, or those which have in some way entered into the life of the individual. The field from which we may draw is very large. Many adult activities have become a real part of child nature, such as house building, constructing vehicles and articles of use about the home, and others too numerous to mention. The projects presented should be so familiar to the child that, as soon as they are mentioned, a mental image presents itself to the mind, thus forming an intelligent basis for work. Do not scorn a project because you have passed the period when it meant much to you, but try to look at it from the child's standpoint and realize how much it means to him.

A short quotation from John Dewey illustrates the point at hand and leaves no doubt as to what we should present. "From the standpoint of the child, the great waste in the schoolroom comes from his inability to utilize the experiences he gets outside the school in any complete and free way within the school itself; while, on the other hand, he is unable to apply in daily life what he is learning in school. This is the isolation of the school, the isolation from life. When the child gets into the schoolroom he has to put out of his mind a large part of the ideas, interests and activities that predominate in his home and neighborhood. So the school, being unable to utilize this every-day experience, sets painfully on another track, and by a variety of means to arouse in the child an interest in school studies." This clearly shows that we must first consider the child's interests, not because we wish to make our work entertaining, but because it gives us a satisfactory foundation.

Design

A designer must go through a certain process of thinking, although often unconscious of the fact, before forming a definite conception of the object to be constructed. Let us determine, if possible, what this process is—and see, if, in substance, it can be made to apply to the child in forming his conception of what he is to create. He must first know to what use the product is to be placed, whether practical or ornamental, and from what material it is to be constructed. Let us suppose that it is to be placed to a practical use, as the ornamental is somewhat foreign to the subject at hand. He knows that in shape and size the product must be so formed as to fulfil the desired end properly. Both shape and size are, of course, dependent upon the individual project.

An analysis of any form of structure will reveal this fact. Let me illustrate by referring to the "Old Missions" of California. Upon coming to California, the Jesuit priests had a many-sided problem to face. They were probably ignorant, from a technical standpoint at least, of the finer principles of architectural design and construction; yet the now decaying structures show a certain fitness for the desired end. They needed shelter and protection from the elements, refuges and strongholds in time of attack, and suitable buildings in which to conduct worship. Every structure, then, must possess the elemenet of strength, must be adapted to the building material, and in keeping with the general traditions relative to such structures. The material used was not durable, but as that was all that was available, it had to be utilized. Every cube was made large and strong, and every wall thick and massive, capable of withstanding great force. In those parts of California where the climate permitted we find colonnades surrounding one or two sides, thus providing cool and comfortable verandas. Simplicity was the keynote

of the building, probably from necessity, but possibly so that all would be in harmony with the general spirit and purpose of their lives. Thus we have relics of the past strikingly in keeping with the spirit of the times, built so as to suit climatic conditions, and in general harmony with the entire project.

To illustrate again, let us refer to an ordinary kitchen table. Table height is about thirty inches. We find that this table is higher, as generally the individual stands while using it. Its top is not round like a dining table, as we are not going to sit around it, and also as it is usually placed against a wall. Everything about it is built for service; meaningless ornaments are omitted, as service and practicability are the desired qualities. Examine the flour and sugar bins; notice that there are no sharp corners to gather dust and refuse. The bottom is round; again see the influence of utility. Its top is not polished, as such would not be in keeping with the use to which it is to be placed. All these in themselves are simple facts, yet they clearly show the idea to be brought out. The table is built for service and convenience. These facts have influenced its height, size, shape and general design and construction.

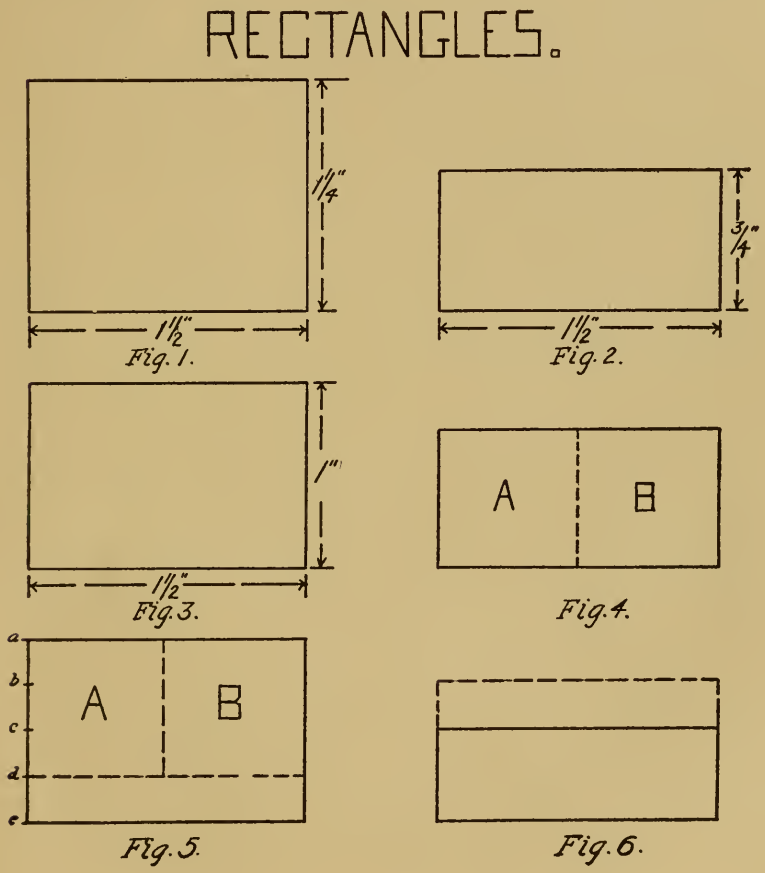
Design in its elementary stage is not a thing of culture and taste alone, but one of reason, without which fantastic and often-times absurd creations result.

There are some fundamentals in design which should here be presented. We are coming to a realization of the fact that simplicity is one of these fundamentals. The day of highly ornamented furniture and houses is over. With simplicity comes a new obligation, viz., that of being true to shape and proportion, as these stand out alone free from ornament. We must recognize the difference between ornamental and constructional design. The ornamental is subordinate to the constructional, as the one is the perfecting or embellishing of the other. We depend for beauty in ornamental design upon placing lines and leaving spaces, and upon massing light and shade; in constructional design we are dependent upon shape

and proportion. As previously stated, both shape and proportion can be determined only by considering the individual project. Utility is the first essential; next and subordinate to utility comes beauty. These two elements must be combined so as to form one harmonious unit. Such is the aim of every architect, builder and designer.

Every project that we would probably present has as a basis either squares, rectangles, circles, or some forms of polygons. In many cases two or more of the above are combined in one project, thereby making it very difficult to lay down any definite rules. We know from experience and observation that some forms of rectangles are pleasing to the eye, while others are repulsive. Carefully examine figures 1, 2 and 3. Compare then and note wherein they differ. Figure 1 is nearly a square. In figure 2 the length is twice as long as the width, while in figure 3 the width is a mean between the other two. It is readily seen that figure 3 is the most pleasing form. Note from figures 4 and 5 how 3 is formed. Have the children draw two squares together, as in figure 4. Below these, draw two others just like the first two. Divide the side d into three parts by placing dots at b and c. Add on the strip d e equal to c d. Now erase all interior lines in both figures, leaving figures resembling 2 and 3. Ask the children which they like the better. Have them look at a book cover, the tops of their desks, and many other rectangles resembling figure 3. Now have them locate rectangles resembling figure 2. Explain to them that this more nearly resembles a panel, as in figure 6. Explain to what use the panel is placed. Teach the children how to draw a rectangle, as in figure 3. They know that it is made of two squares plus a strip one-third of the width of one square. Suppose the length to be eighteen inches, then the width of figure 4 is nine inches, and of figure 5, twelve inches, as one-third of nine, or three, is added to nine. Go through this process is various ways, using other numbers, until it is perfectly clear to the children. This should be presented when they are about to

construct some piece involving the use of a rectangle of this shape. Avoid the use of rectangles resembling figure 1, as they are awkward in shape. It is very seldom that they are used in any way.



Suppose that we have made a mounting for a calendar or match box resembling in shape figure 7. We must first locate the calendar or match box on the mount, as the nature of the ornament depends entirely upon this position. Figures 7 to 12 illustrate this principle. It will be seen at a glance that a rectangle seems better adapted to the purpose than a square. Compare figure 7 with figure 12. Let us analyze the different figures. In figure 7 we have placed the mount in the lower right-hand corner, with the year to the left. The weight of the ornament must be in the upper left-hand corner, so that it may be balanced properly. A spray of leaves or flowers seems appropriate. In figure 8 we have placed the mount in the middle, below the center, and cut on the lines which form the ornament along the line ae. This necessitates an evenly balanced design filling either side of the mount.

In figure 9 the calendar is placed in the same position as in figure 8, the ornament consisting of curves and border lines. After placing the numbers designating the year, the design seems complete. In figure 10 an upright calendar is used and is placed on the left-hand side, thus requiring the ornament to be on the right side. The smaller mount, upon which the calendar and design are placed, may be pasted on a larger mount. Note the effect produced by using border lines. In figure 11 the mount is placed in an upright position, and an upright calendar is also used. A flower or shrub with long and slender leaves and foliage will appropriately fill the remaining space. Figure 12 clearly shows that a square is not so well adapted for this purpose as a rectangle.

Let us again examine figure 8 (a). Notice the spacing along the line a e. Note that the spaces are irregular. Compare the distance a b with b c. In figure 8(b) the spacing is regular. Compare the distance a b and b c. Pleasing effects can seldom be produced by regular spacing. This will be found to be true in nearly every design, whether ornamental or constructional.

BALANCE AND ORNAMENT.

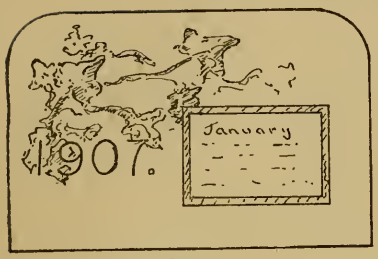


Fig. 7.

Fig. 8. a.

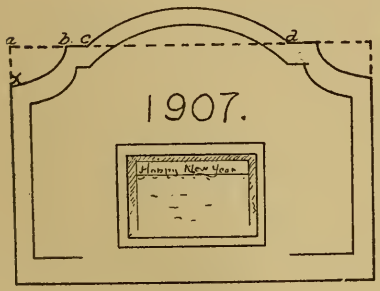


Fig. 9.

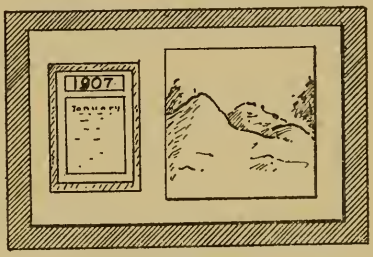


Fig. 10.

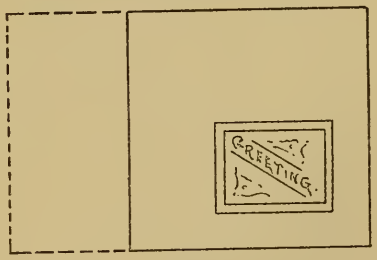


Fig. 12.

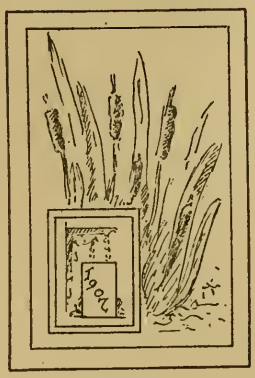


Fig. 11.

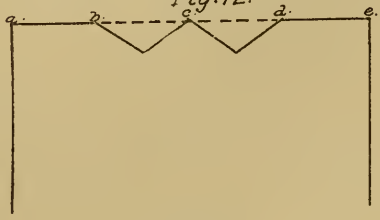


Fig. 8. b.

In figure 9, as above stated, curves have been used in forming the design. Note how they are constructed. The curve designated by the points c d is not a semi-circle, but a segment of a circle produced by locating the center on a point on the median line some distance from the top of the rectangle. Note also the curve bounded by b x. It is not a quarter-circle, as might be supposed at first glance. The curve can be based upon either the parabola or ellipse. It is always a pleasing curve. It can be drawn freehand by locating the points b and x where the curve comes into contact with the lines forming the rectangle. Avoid, if possible, the use of semi or quarter-circles. They are apt to look stilted and are seldom as pleasing as a segment either greater or less than a half or quarter-circle.

All of the points mentioned cannot be drawn from the children, nor will they realize for a long time their full significance. Mention them from time to time as opportunity may arise; never fail to call attention to them when you are constructing something which demands their application.

Some are of the opinion that nothing should be presented to the child that is not a perfect type of a class. We are apt to forget that growth is not the result of impression alone, but rather the combined process of impression and expression. Which means most to the child, the elaborate design planned by the teacher, or the simple one planned by the individual or the class? No other answer can be given than the latter; first, because we are assured that such a plan is in keeping with his own understanding; and second, because from it we know what his ideas are, and therefore have a satisfactory basis upon which to build.

We believe in the cultivation of the finer senses. The problem is to find tangible methods for such cultivation. As was before stated, it must be a two-fold process, with the emphasis laid upon the side of expression. Development cannot be forced. Before reaching the advanced stages of culture, we must pass through the cruder ones. Such has been the history of the development of the individual and the race.

Accuracy

We all admire the splendid productions of the French and Germans, and realize to a keen degree that American workmen lack that care and exactness which is characteristic of some of the European nations. We all desire to raise the standard of excellence in this line among our own people. We realize also that this process must be begun in early youth.

Is there such a thing as the general habit of accuracy? One may be able to draw a line between two dots and measure to a nicety a given distance, yet that same individual might not be able to form a series of letters between two given lines. A boy may be able to plane a board to a given line and yet be unable to perform a similar act with a saw. Thus we see that each operation carries with it its own difficulties and requires specific training. The only element of similarity in the above operations is that of care, keeping in mind the necessity for careful effort.

The above is presented only to show that if you do succeed in getting pieces of work accurately constructed, it is not going to be a cure for all problems of inaccuracy which you find in childhood. Accuracy is not the keynote of Manual Training, at least from an elementary standpoint. Such is an utter impossibility, as it is a generally recognized fact that accuracy is not a characteristic of childhood, and Manual Training must be based upon the innate powers and potentialities of childhood, seeking rather to build upon characteristics naturally possessed by children and so developing and shaping them as to fit the individual for future usefulness.

There are many reasons why we say that accuracy is not a characteristic of childhood. Look at it from a physical standpoint. We know that the large muscles develop first; the smaller ones later in life. Where other than this is the case, we have an abnormal development which is apt to interfere with the future well-being of the individual. It is obvious

that when too much stress is laid upon the small things we are tearing down rather than building up. The young eye cannot faithfully discern minute measurements, and the undeveloped hand cannot put the pencil in the desired place.

Accuracy is also a mental attribute. Mind, hand and eye must work harmoniously. Thus, a three-fold development is necessary. This cannot be forced. We must guide and cultivate, looking forward to the time when the development will be complete in adult life.

Great value results from the effort of the teacher in training the child to be accurate in his construction work. He learns that he must work slowly; that an approximation is not sufficient, and that careful planning is essential to creditable production. Thus the elements of painstaking and foresight are cultivated, and these are bound to influence his work in the schoolroom along other lines. Thought must precede every profitable action.

Let us plead for that rational degree of accuracy which can reasonably be expected from childhood. Those dealing with children will appreciate what has been said. It is for us to educate the outside world so that when they examine the finished product they may see it through the eyes of the child. Inaccuracy is very evident in construction work, and it is our duty to point out such errors. The children will see what is meant, for they are dealing with visible material, and not with indefinite generalities. Let us be sparing in criticisms, realizing that accuracy is not a characteristic of childhood, and that too much emphasis and overdue effort will result in tearing down rather than in building up.

Definite Processes

In order that we may have some foundation upon which to build, it is necessary that we present a few definite processes. It has been found by experience that these processes bring forth the best results. For this reason they are presented in this way:

The pencil chosen should be hard and well sharpened. Light lines are the only kind to be used, as they are the best adapted for general purposes. All dots should be light, so that they will not be seen after the line is drawn. Scoring is the process of drawing a sharp instrument over lines where the cardboard is to be folded. It is done so as to make a neat fold. It is not necessary to score light cardboard or thin cover-paper before folding. The opened blade of the scissors may be used with success. Always use the ruler to guide the knife or scissors, so that the line will be straight.

Generally the cardboard which is given to the children has not perfectly square corners, so that the first process is to square one corner. The children should be provided with a right triangle. See figure 13. It can be made of either wood or cardboard. The first process in squaring one corner is to draw a line across the bottom of the paper, as line a b in figure 14. This line should be drawn close to the edge of the paper. Place the triangle on the line in such a position that when a line, such as x y is drawn, a right angle is formed in the lower right-hand corner. This is always the first process. From this square corner and these lines, all measurements should be made. We have no further use for the triangle in the present figure. Suppose that a six-inch square is to be drawn. Measure from the corner x to the point k a distance of six inches and place a dot. Measure from the point y a distance of six inches and place a dot. at t. Now draw the line t k.

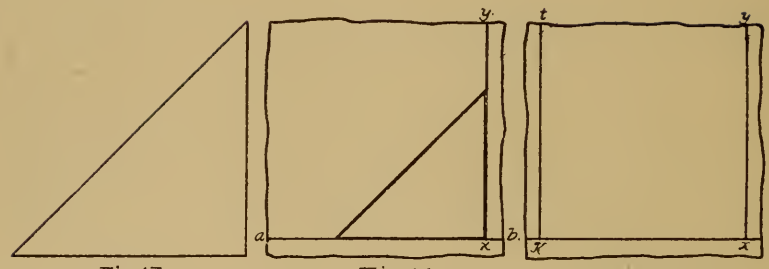


Fig. 13. Fig. 14. Fig. 15.

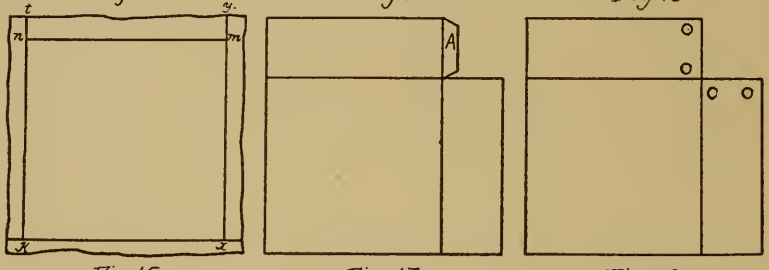


Fig. 16. Fig. 17. Fig. 18.

We have a figure resembling 15, six inches in width and indefinite in length. Now measure from the point x along the line x y placing a dot at m which is six inches from x. Measure from the point k along the line k t, a distance of six inches placing a dot at n. Connect the dots n and m. The result is a six inch square.

All cutting is done in the ordinary way with scissors. Open them wide and take a full stroke, keeping the eyes on the line. Hold the paper each time so that the cutting will be done on the right side. The main difficulties in pasting are applying too much paste and allowing the children to work with dirty fingers. A small cotton cloth can be used to advantage when they are ready to paste. Have them do the rubbing with this instead of with their fingers. Do not allow them to apply too much paste.

There are many ways to fasten together the corners of boxes, etc. Figures 17 and 18 show the ways most commonly used;—that of pasting edges and lacing. The pasting edges should be a trifle over a quarter of an inch in width. The corners should be clipped off so that they will not be so conspicuous in the finished product. If the method shown in Fig. 16 is used, the corners may be laced with silk floss, ribbon or raffia.

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*Method of Presentation

In what has preceded it has been shown, in general, what to present; how to work out the design; how to perform certain definite processes, and how to present the work in general. It now remains for us to elaborate upon the method of presentation. This may best be done by taking certain definite projects and working them out in detail, showing just how they may be developed in the classroom.

Pencil Box

Suppose the project to be a pencil box, and that the class is not at all familiar with the work. It will be necessary, at first, for the class to see that any box has three dimensions—length, width and height, or depth. If you ask them the size of a certain box, at first they will give invariably only one dimension, not realizing that they have omitted the other two. Develop this point by illustrating with several boxes till it is perfectly clear. Have the class name over the various parts, telling which are always alike in size and shape. They will readily see that bottom and top, two sides and two ends may be grouped together. Now return to the box at hand. Ques-

*The plans under this division are given only to assist the reader in following the suggestions. They should never be presented to the children in this form.

tion them in regard to pencil boxes which they have seen—as to size, shape and general construction. Most of the answers will probably apply to wooden boxes. You will find that there are many kinds which could be constructed from cardboard. They will probably mention these—a plain box, long and narrow, without cover; a plain box, long and narrow, with cover fastened to one side; a plain box, with a cover resembling another box minus the two ends. Let us decide upon the first box mentioned. By this time the children have a fairly clear mental picture of the product. It now remains for us to analyze this picture, reduce it to its component parts and then construct. Explain to them that the box is to be made from one piece of cardboard, by means of cutting, folding and pasting. Let us proceed to build it up. It is well to have this done at the blackboard, one child at a time doing what the class dictates. Show them that the bottom must first be drawn, as all the other parts are fastened to this. Before this can be done, its size and shape must be known. Referring under "Design" to what has previously been said, we know that the box must conform to the size and shape of the object which it is to contain; therefore it must be long and narrow. Determine the definite measurements and have the child draw the bottom on the board. See figure 19, a b c d.

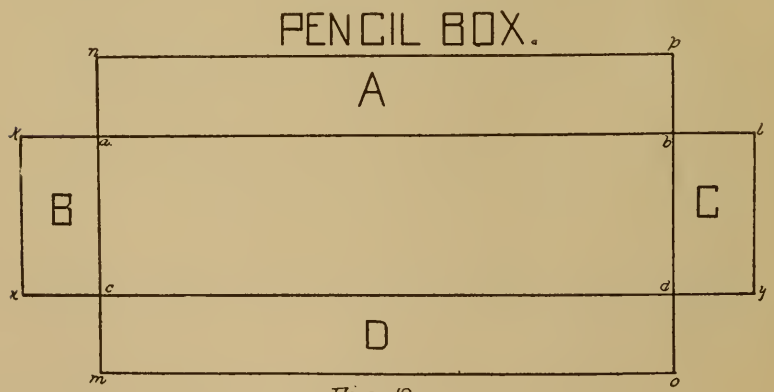

Fig. 19.

Before going further, determine the height. After this is done, have the children point out the places on figure a b c d where the sides and ends are fastened. Now have the sides and ends drawn, as A B C D. If the class has trouble in following the above process, begin again; this time having each child work at his desk, using paper and pencil. Draw the bottom, not stopping to measure or rule lines, but simply getting the relative size and shape. Now tear this out. Draw and tear out the two sides and ends in the same way. Arrange and hold these various parts together so as to form the box. Now let the sides and ends fall and we have a figure resembling 19. In order that we may be sure that every child knows what he is doing, let the class pass to the blackboard and build up the same thing again. At present we will not refer to the method of fastening the box together, as too much at once is confusing. Above all, go slowly.

Now let the box be drawn very carefully. It is well to have it drawn first on common manilla paper, so that if there are mistakes too much cardboard will not be wasted. This time we will not build it up, but draw it in a different way. Ask the class to point out the long lines, such as k l and x y; also lines m n and p o. As has been stated, we must first square the lower right-hand corner. Do this according to the process explained under the "Definite Processes." Let us suppose the box to be nine inches long, two inches wide and one inch deep. First draw all the horizontal lines, beginning at the bottom and working toward the top. We already have the line m o, as it is one of the lines forming the right angle. Draw the line x y one inch above m o, as the distance between these lines is the height of the box. Draw the line k l two inches from x y; this distance is the width of the box. Draw the line n p one inch from k l, thus forming the other side. Now draw the vertical lines, beginning at the right and working toward the left. We already have the line l y, as this is the other line forming the right angle. Draw p o one inch from l y; this is the width of one end. Draw m n nine inches from

p o, this distance being the length of the box. Draw k x one inch from n m, as this is the width of the other end. This, in substance, is the process through which we must pass in drawing a box or anything similar.

We must now consider the problem of fastening the box together. It is well at first to use the pasting flaps; these may be fastened to the ends B C, or the sides A D. Draw these according to directions given under "Definite Processes." Cut, score, fold and paste, and the box is complete.

Portfolio

As in the case of the pencil box, suggest the problem to the children. It may be used for post cards, or something similar. The children are more or less familiar with this project, as they have seen portfolios for sale at the stationers', and possibly are in possession of one of them. There are many forms and varieties of portfolios; a great variety will be suggested by the children, so the field from which we may draw is very large. Some forms resemble envelopes, some little booklets, while others are constructed elaborately, with various compartments resembling a folding purse. For the sake of uniformity in presentation let us decide upon a very simple one, resembling, in a degree, an envelope without flaps pasted. Discover the various parts. We find them to be the face, similar in shape to the postal, the two ends and the flaps at the top and bottom. See figure 20. Determine the size of the face. This must be a little larger than the postal card. Suppose we decide upon six inches by four inches. Let us test this rectangle and see if it is of good form. Dividing the length into two parts gives us three inches, or the size of the squares. One-third of three is one; added to three, gives us four inches for the width. Have this much drawn on the blackboard. From the construction of the pencil box, we know where the end and side flaps must be placed. It is well at this stage to draw lines of indefinite length, extending from the rectangle just drawn. See the diagram and note the lines Z z, etc.

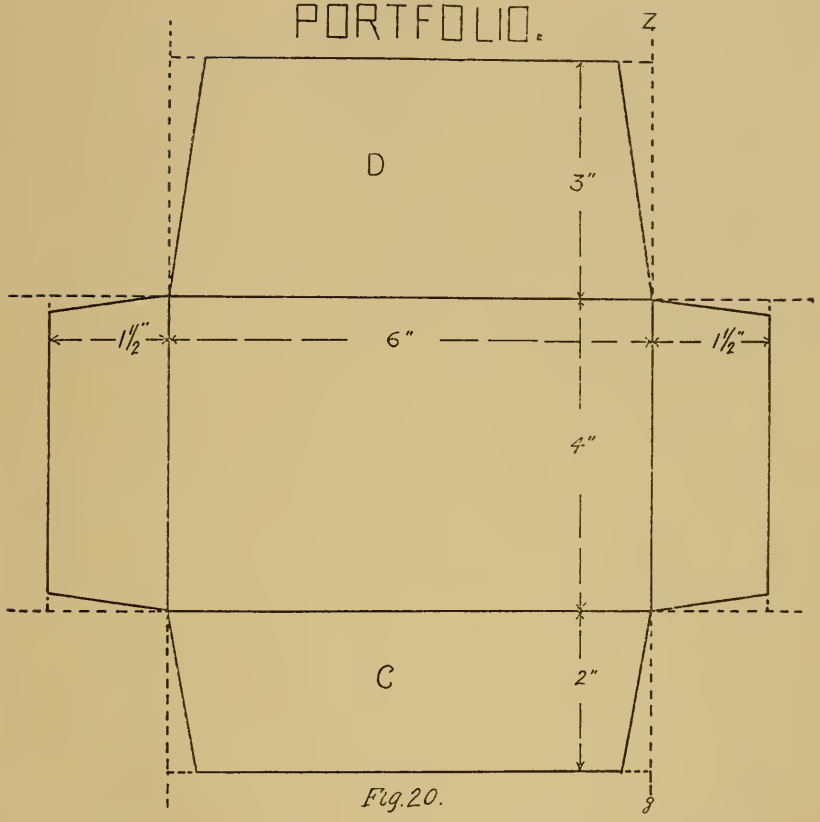

Fig. 20.

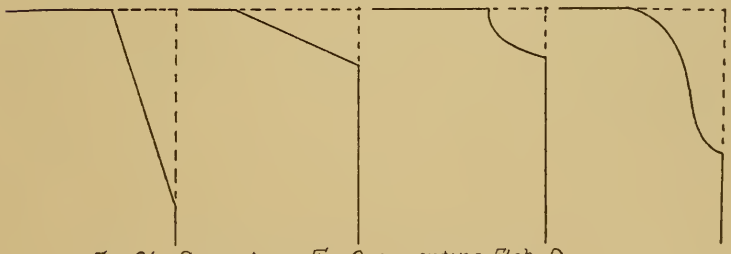

Fig. 21. Suggestions For Ornamenting Flap D.

These lines bound the width of the flaps, and help us in determining their size. The side flaps are to be folded first, the bottom flap next, and finally the top flap. Now consider the width of the side flaps. Ask the children how wide they would have to be so as to meet in the middle of the face. It will be seen that they will be just as serviceable if they are not so long as this, and that they will probably look much better if they are made narrower. Let us make their width one and one-half inches. Consider, now, the two remaining flaps at D and C. Suppose these were just to meet when folded together. They would not appear well, as there would always be a space between them. It is better to have the top one overlap the under one and come somewhat below the middle, so as not to leave two regular spaces on the back. Let us make the bottom one two inches wide; it will then reach the middle. Make the top one as much wider as we wish it to extend over the bottom one. Suppose it is to overlap one inch, then the whole flap must be three inches wide. Have all these flaps placed on the drawing already begun on the blackboard. Now consider the ornamentation of the flaps. See figure 21. Allow much range in this respect.

We must now decide upon the method of fastening the portfolio together. It might be tied with ribbon or silk floss, or a tongue might be added to the top flap and a slit made in the lower flap to receive it. Cut the slit with a knife, as it cannot be done well with the scissors. After folding and ornamenting, the project is completed.

No directions are here given for drawing on the cardboard, as the same methods already explained under the pencil box will apply in this case.

Bank

In general, this must resemble a box, somewhat modified in form. The same general method used in the construction of the pencil box is applicable in this case. As before stated, first call upon the child's store of knowledge relative to the proposition. He will call to mind the metal bank, just the diameter of a 5-cent piece; the square metal bank; the miniature house with a slot down the chimney, or possibly the metal pig with an opening on the back. All these ideas and experiences may be utilized in developing the present problem. For the sake of convenience in presentation, we must decide upon one form, either a square or rectangular box, with a slit cut in the lid to receive the coin.

Instead of developing this further as a class project, let it be an individual one, making your directions and hints so general that they will apply to all, even if the dimensions are not all the same. All should be provided with paper. Before further presentation, review the various parts of any box, recalling again those parts that are always the same. Now lead the class by questions and suggestions till every one has some kind of a mental picture of a bank. These will probably not be uniform. Now have the child write on a corner of his paper the dimensions of the bottom of his bank; in the same way have him write the dimensions of the four sides. The problem is reduced now to an individual proposition for each child, and he must necessarily do his own thinking. Have each one now draw his bank roughly, using his own measurement. Then place the top and pasting edges. Let him label the various parts as he draws them, so that he will not become confused. Have the bank cut out and folded. He now sees that he must in some way improve the top or cover so as to prevent it from falling down into the box. Many ways will be suggested. It may be done by adding on the flaps A and B and folding them at right angles to the side. See figure 22. Another flap at D will tend to hold it in place. The slit for

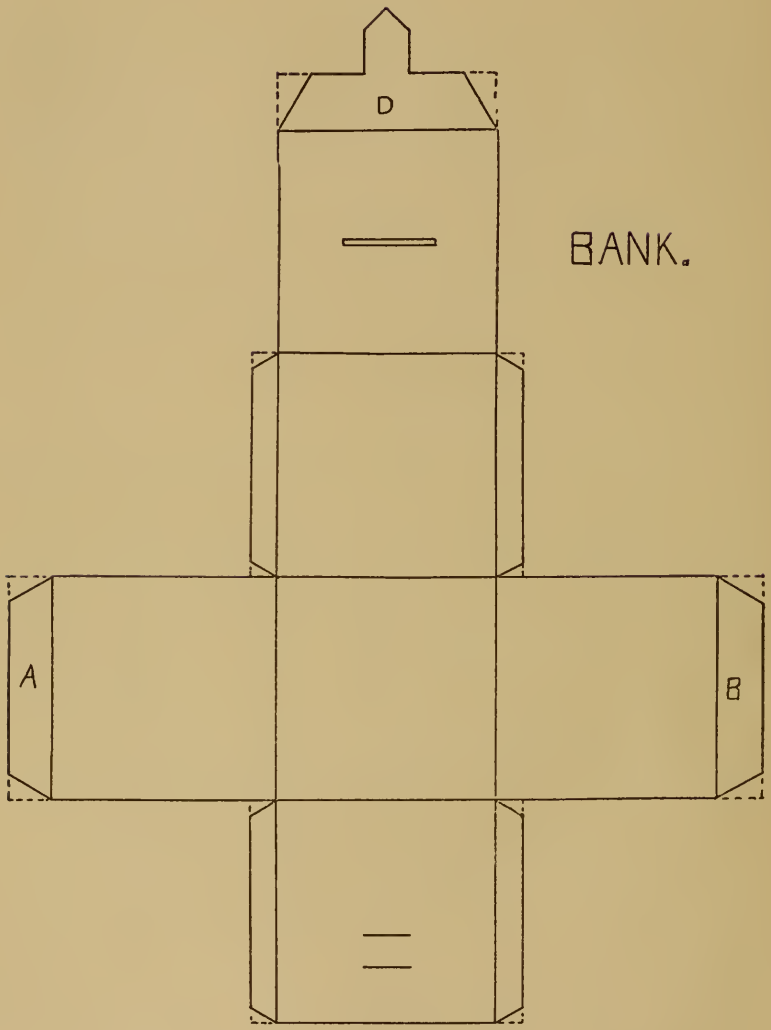

Fig. 22.

the coin must be cut with a knife. Follow the same directions in drawing the bank as given for the pencil box. In drawing the first two lines that form the right angle, place them far enough from the edges that the flaps at A and B may be drawn outside the figure. At first do not consider them at all; add them when the entire drawing is finished. Cut, score, fold and paste.

Hexagonal Box or Basket

Before this project is commenced we must teach the children the parts of a circle; such as radius, diameter and circumference; and also, how to construct a hexagon, or six-sided figure. Tell them that all the sides of the hexagon must be the same size. Have a child draw a rough picture of a hexagon on the board. It is our purpose to develop the method of drawing this figure rather than to dictate the various steps. Have the child draw a circle about the hexagon, showing that it resembles this figure very closely, and that it is its basis. Examine figure 23. Draw the diameter a b, thereby showing that there are three sides on each side of this line. Locate the center of the circle at O, showing that this is also the center of the hexagon, and that the distance a o is just the same as the distance a x, or any of the sides.

Let the children now draw a circle on a piece of paper, this time using their compasses, so that the figure will be exact. Insist that they keep their compasses set at the same radius as used. Draw the diameter. They now have all the facts needed; they know that all the sides are uniform, and the same size as the radius of the circle. Call these facts to mind, and let them devise the method of drawing the sides. At first they may measure the distance a x with their rulers. Show them that the easiest way is to use the compass, as this will insure all the sides being alike. Show them how to "strike an arc," using their compasses, and let them draw the lines completing the hexagon.

Our problem now is very simple. It now remains for us

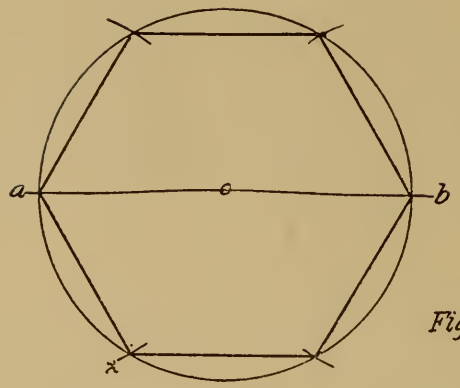

Fig. 23.

HEXAGONAL BASKET.

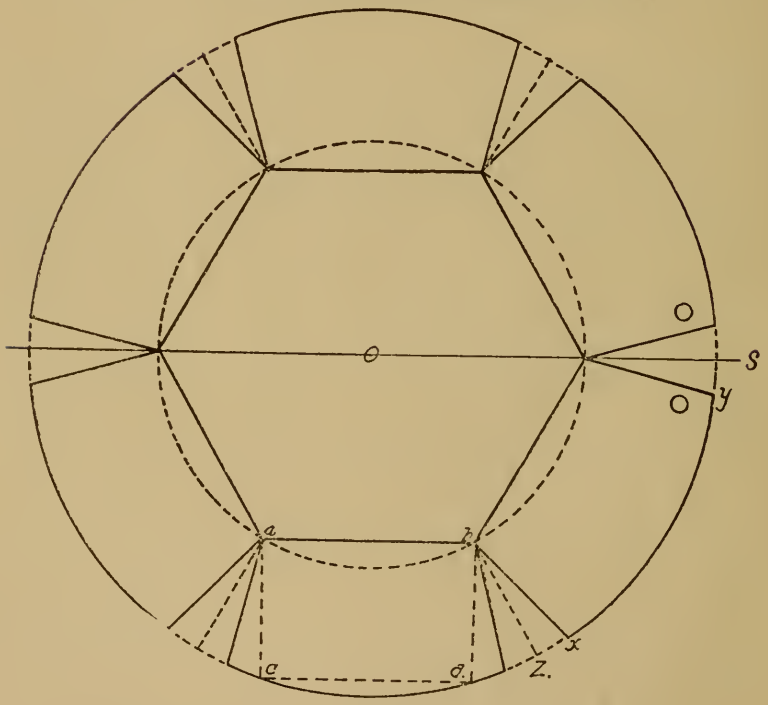

Fig. 24.

to determine the measurements for the basket, and then construct. Have this done as a class project. All that is needed is the diameter of the bottom and the height of the sides. After having determined the diameter of the bottom, draw the hexagon. Then have the children locate the surfaces where the sides must be attached. There are at least two plans which we may now follow. We may form the sides so that when folded they will be at right angles to the bottom. If we do this, the sides will resemble a b c d in figure 24. The other plan is to form the sides so that they flare at the top. If this plan is followed they will resemble the sides b x y. If the sides are to be at right angles to the bottom, a b c must be a right angle, and may be drawn with the square. In either case, we must draw another circle, using a radius equal to the sum of the bottom radius and the width of the sides. If the sides are to flare, we must first locate the points on the circumference which would be used in forming a hexagon in the outer circle, as at Z, S, etc. These points may be obtained in the same way that the first hexagon was drawn, or by drawing a line through o b and continuing it until it touches the circumference. The magnitude of the flare depends entirely upon the distance x y. This basket looks well when fastened together with silk floss or baby ribbon.

Use and Selection of Materials

It is well when the class is first taking up a project to have it worked out on plain manilla drawing paper, or similar inexpensive material. There are many kinds of paper and cardboard ordinarily used. Every kind is manufactured in various sizes and weights. These vary with the various manufacturers.

Cover paper is a good material to use for many things, being best adapted for projects ornamental in nature. A light-weight paper is seldom appropriate for boxes, or articles

of a similar nature. It comes in a great variety of colors and shades. every dealer having certain shades which are manufactured only by his firm. It is called cover paper because it is commonly used for covers for booklets, etc. It is usually sold by weight—so many pounds to the ream—depending, of course, upon the thickness of the sheet.

Tag board is a very serviceable paper. It is much heavier than cover paper. Ordinarily it is used for shipping tags, etc. It, also, comes in a variety of weights and sizes. The size and weight used depend upon the individual project. Boxes, baskets, etc., can be satisfactorily made from this material. This paper is also sold by weight.

Mat board, the same as used by picture framers, can be utilized very nicely for calendar mounts, covers for booklets, etc. This is more expensive than the others mentioned. It also comes in various sizes and weights, and is generally sold by the sheet.

Occasionally we have use for quite heavy material. Strawboard will do when such is needed. It comes in various thicknesses, and is sold by the bundle. These are usually designated by numbers. The bundles are all alike in weight, but vary in the number of sheets they contain. The number of sheets they contain determines the number by which they are listed. This board is yellow. When this color is not desirable it can be covered with light paper, or some ornamental design drawn on light drawing paper.

Binder board is a board used by bookbinders for covers, etc. This may be used in making book covers, or mounts for various purposes. It is quite expensive and is sold by the sheet.

In some cases we may wish to fasten corners together with gummed paper. This may be purchased in sheets and cut into strips of the desired width. It can also be procured in various colors, and can be used for ornamenting.

Bristol board may be used for some projects. It is very satisfactory material with which to work, but the price makes

it almost prohibitive. It comes in various colors and weights, and has a glazed surface.

Conclusion

It is intended that this manual be suggestive. Any plan for working out in your class a certain project which you find successful is far better for you to use than one which has been copied from someone else. The projects herein presented are typical; it is therefore believed that no trouble will be experienced in working out other projects not mentioned. The individuality of the teacher determines the method of presentation to a great extent. A certain project can seldom be presented twice in the same manner, as the personality of the class is bound to have its effect. When this is the case, it is a hopeful sign, as you then know that the children are doing original thinking.

Many occasions will arise for the application of the facts learned in arithmetic, and often, by applying certain arithmetical principles in their cardboard work, a great amount of drill will be saved, and the facts will be so impressed that they will never be forgotten. This is especially true in the study of fractions. Before finishing the course in cardboard construction, the children should be very familiar with their rulers. They should be able to measure any distance accurately and quickly. They should also be familiar with, and know how to construct, squares, rectangles, circles, etc.

All the definite processes necessary for full and complete expression have been mentioned. The main point of the whole subject is expression. This we are very apt to overlook in our zeal to bring forth immediate results, and in our desire to have the child conform to adult standards. Through expression comes power, which alone is the test of the effectiveness of our teaching.

Suggestive List of Projects

Barn.
House with Gable Roof.
House with Hip Roof.
Street Car.
Wagon.
House Furniture.
Pencil Box.
Jewel Case.
Card Case.
Portfolio.
Stamp Album.
Transfer Case.
Tooth Pick Holder.
Match Box.
Match Scratcher.
Pocket Comb Case.
Bank.
Whisk Broom Holder.
Glove Box.
Candy Box.
Jack-o'lantern.
Woven Basket.
Woven Box.
Needle Case.
Hexagonal Lantern.
Hexagonal Box.
Hexagonal Basket.
Wall Pocket.
Calendar Mount.
Suit Case.
Picture Book.
Book Mark.
Yarn Winder.
Envelope.
Picture Frame.
Pin Ball.
Ribbon Box.
Necktie Box.